PATENT SPECIFICATION

DRAWINGS ATTACHED

871,021

Date of Application and filing Complete Specification July 12, 1957.

No. 14988/60.

(Divided out of No. 871,020).

Complete Specification Published June 21, 1961.

Index at acceptance:—Class 80(1), G7C2.

International Classification:—F06h.

COMPLETE SPECIFICATION

Improvements in or relating to Cast Worm Wheels

I, JAMES ALBERT HATCH, a citizen of the United States of America, of 1357, Franklin Street, Detroit, Michigan, United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to cast worm wheels. In referring herein to worm wheels, it is to be understood that there is meant a worm wheel which is conjugate with a given mating worm, and which can be employed for long-life, efficient transmission of mechanical power. Where a worm wheel has to be employed for such transmission it is essential that the mating teeth be truly conjugate. A worm wheel of this character is hereinafter referred to as a "precision" worm wheel. Merely casting the teeth in accordance with the usual procedures without further machining will not produce precision worm wheels. Known precision worm wheels for such transmission of power are prepared by machining a blank to form the teeth, or by casting the teeth and thereafter machining the cast teeth to the final shape to ensure that they are conjugate to a given mating worm. Where the teeth are directly formed by machine, or are first cast and then machine finished, the finally produced teeth have surfaces characteristic of metal which has undergone a machining operation. The removal by machining of a substantial layer of metal from the blank cast by usual procedure exposes a grain structure at the working surfaces of the teeth which is non-uniform.

The invention is based upon the realisation that a superior precision worm wheel can be obtained if the finished teeth have surfaces produced by casting immediately against a metal mould, such surfaces not being then subsequently machined. This requires that the moulding shall be so carried out that the moulded teeth have a desired finished size and shape equally as accurate as that of machine generated teeth to ensure that they are conjugate with a given mating worm. Thus, the invention is concerned with worm wheels which are produced in a manner distinguishable from known practice in that hitherto the final finished accuracy of the teeth of a precision worm wheel has been obtained by appropriate control at the machine stage, whereas it is now proposed to obtain the final finished accuracy at the moulding stage. It has, for example, been proposed to produce worm wheels by die casting, but it has been the practice to obtain the finally finished worm wheel by a subsequent machining operation. In this connection attention is directed to the book entitled "Die Castings" by Chase published by J. Wiley & Sons, 1934. At page 150 of this book there is a passage reading as follows: "Worms and worm wheels are readily die-cast, although, for precision gears of this type, on which very smooth surfaces are required, some machine work is necessary and allowance for this must be made in the casting, as it must, of course, in any type of gear where such machining is to be done".

In contradistinction to what was previously known, in accordance with the invention, there is provided a precision worm wheel having teeth conjugate to a given mating worm against which said worm wheel is to be run, said teeth possessing at and inwardly of the mating and running surfaces thereof the metallurgical characteristics of metal which has been cast against a metal mould, wherein the tooth surfaces are equivalent in form and finish to those of a generated machined worm wheel, the grain structure of said teeth at and for a substantial distance inwardly of said tooth surfaces being uniform and extending from the root, sides and crest of each tooth into the body of the gear.

In British Patent Application No. 22216/57 (Serial No. 871,020), there is described

[*Price 3s. 6d.*]

Price 4s 6d

a method of manufacturing a mould suitable for use in the production of a precision worm wheel as above defined, and apparatus for forming mould cavities in mould blanks for producing such a mould.

It will be apparent that the product defined above will be a worm wheel having sufficient precision as to its tooth contours to be used immediately with a mating worm without it first being necessary for a machining operation to be performed. Indeed, although a lapping operation may be performed in which a minute amount of metal is removed, this is by no means essential.

For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:—

Figure 1 is a sectional elevation illustrating generally the manner in which segments having mould cavities are arranged to form a ring-shaped composite mould, and

Figure 2 is an end elevation of a precision worm wheel produced by casting in a composite mould of the kind shown in Figure 1.

Referring to the drawings, the ring-shaped composite mould shown in Figure 1 is built up from a plurality of segmental blanks B which are produced by sawing segments from a continuous circular blank casting (not shown) which has the same radial cross-sectional proportions as the sawed segmental blanks B. Mould cavities MC are formed in each segmental blank B in the manner described in the aforementioned British Patent Application No. 22216/57 (Serial No. 871,020).

The radial dimensions and sectional dimensions of the circular blank casting are such that following the sawing of the segmental blanks B therefrom and the machining of the mould cavities MC in the latter, a precision worm wheel such as is shown in Figure 2 chill cast against a ring-shaped composite mould such as is shown in Figure 1 will have the desired dimensions in regard to its diameter, width and tooth proportions. Each of the segmental blanks is cut from the aforementioned continuous blank casting in such a way that it has a predetermined face-to-face or top-to-bottom bias such as is indicated by the numeral 175 in Figure 1.

In order to produce a precision worm wheel of the kind shown in Figure 2, it is necessary that the inner surface of each segment B should be generally concave and that the various mould cavities MC which are cut therein should result in convexities upon the concave surface.

In machining each segment B and in cutting the various mould cavities MC, casting shrinkage factors must be taken into account. This is done on the basis of radial shrinkage, i.e. assuming that the casting shrinks towards the centre. The composite mould shown in Figure 1 is therefore made oversize so that, as the molten metal contracts on cooling, the cast worm wheel will be within desired tolerances. A typical tin-rich bronze which may be employed in casting worm wheels in accordance with the invention is designated S.A.E. No. 65, and has a content of approximately 89% copper and approximately 11% tin. This is a bearing alloy possessing very suitable metallurgical properties for a worm wheel since it has a melting point of over 1900° F. and a tensile strength exceeding 50,000 pounds per square inch. It is not, of course, essential for this particular bearing alloy to be used but it is preferable that a non-ferrous alloy should be employed having a melting point in excess of 1550° F. The usual shrinkage allowance for the tin-rich bronze described above is 1/64 of an inch per inch. Thus, for the casting of, say, a twelve inch diameter precision worm wheel, the segments B are made as if the wheel were twelve and three-sixteenths inches in diameter.

A worm wheel chill cast in the manner just described is so precise in dimension that it may be simply run in to render it suitable for its intended purpose. Indeed, such a wheel may be used directly as cast, particularly in cases where at least a small proportion of lead is added to the bronze to give it lubricating properties. One of the important advantages associated with the above described casting of worm wheels without subsequent machining, is that the finished precision worm wheel has highly desirable metallurgical properties, which thus enhance its operating characteristics. The segments B forming the composite mould shown in Figure 1 serve as chills, i.e. act to rapidly freeze and cool the metal in and around the wheel teeth. This provides the desired metallurgical structure in the teeth and the area extending radially inwardly somewhat beyond the roots of the teeth.

A photomicrograph of a section of such a worm wheel through a tooth thereof reveals a uniform distribution as to its grain structure throughout, from the roots, sides and crest of each tooth formation inwardly into the body of the gear, as a result of the chill casting to accurate ultimate gear proportions. This is possible only when the mould against which the chill casting is performed is itself accurately machined in regard to the tooth proportion. By contrast, the removal by machining of a substantial skin layer of metal from a cast gear blank in conventional gear-cutting operations exposes grain structure at the working surfaces of the gear teeth which is non-uniform. Improved tensile strength and wearing qualities are thus exhibited by precision worm wheels in accordance with the invention.

Another important advantage of the inven-

tion is in the saving realised by the reduction in the total metal required for a worm wheel. Where worm wheel teeth are made by machining, metal must be provided for the cutting tools to remove and so shape the tooth form. In casting, of course, this metal is not required and something in the order of 50% of metal around the tooth area is saved by the present invention. Since most worm wheels are formed of bronze, in particular tin-rich bronze alloys, both the principal component metals of which are relatively expensive, the importance of the above mentioned saving will be readily appreciated.

WHAT I CLAIM IS:—

1. A precision worm wheel having teeth conjugate to a given mating worm against which said worm wheel is to be run, said teeth possessing at and inwardly of the mating and running surfaces thereof the metallurgical characteristics of metal which has been cast against a metal mould, wherein the tooth surfaces are equivalent in form and finish to those of a generated machined worm wheel, the grain structure of said teeth at and for a substantial distance inwardly of said tooth surfaces being uniform and extending from the root, sides and crest of each tooth into the body of the gear.

2. A worm wheel as claimed in Claim 1, and composed of a non-ferrous alloy.

3. A worm wheel as claimed in Claim 1 or 2, and composed of a metal alloy having a melting point exceeding 1550° F.

4. A worm wheel as claimed in any preceding claim, and composed of bronze.

5. A worm wheel as claimed in any preceding claim, and composed of an alloy of approximately 89% copper and approximately 11% tin.

6. A worm wheel as claimed in any preceding claim, and composed of bronze, wherein the bronze has a melting point not substantially less than 1900° F. and has a tensile strength exceeding 50,000 pounds per square inch.

7. A precision worm wheel having teeth that have been produced by casting immediately against a metal mould, substantially as hereinbefore described with reference to Figure 2 of the accompanying drawings.

HASELTINE, LAKE & CO.,
Chartered Patent Agents,
28, Southampton Buildings,
Chancery Lane,
London, W.C.2,
Agents for the Applicant.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1961.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

871,021 COMPLETE SPECIFICATION
1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

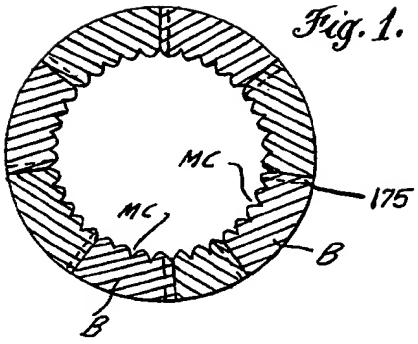

Fig. 1.

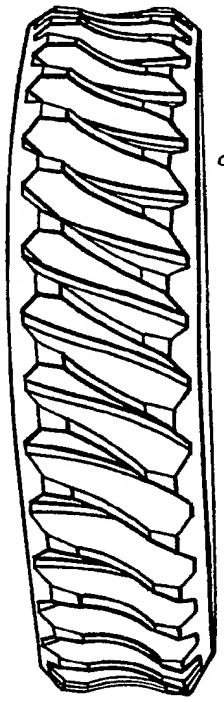

Fig. 2.

871,021 COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

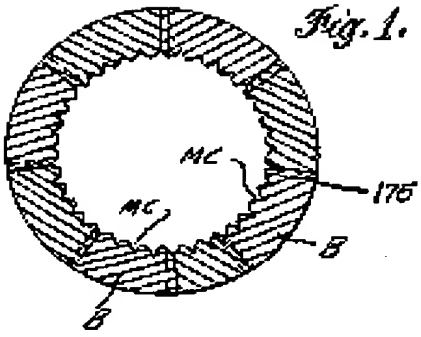

Fig. 1.

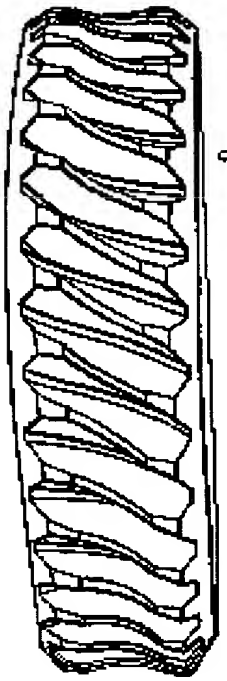

Fig. 2.